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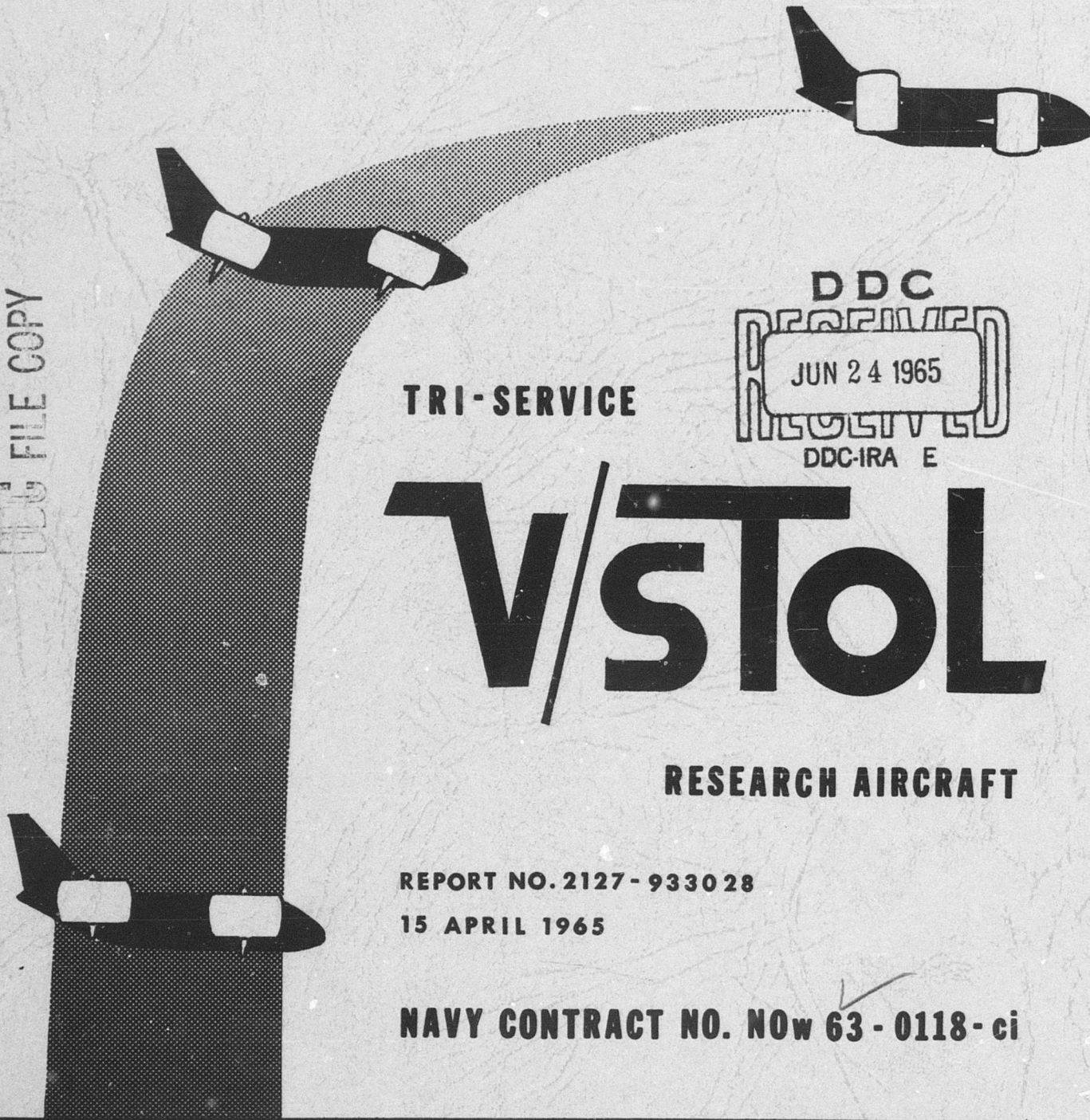
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**X-22A PROGRESS REPORT NO. 28**

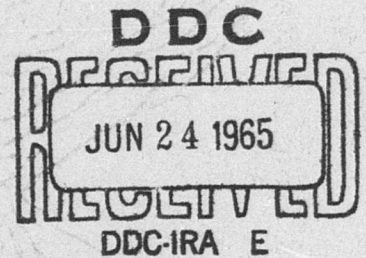
**MARCH 1965**

AD NO. 465214

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**TRI-SERVICE**



**V/STOL**

**RESEARCH AIRCRAFT**

**REPORT NO. 2127-933028**

**15 APRIL 1965**

**NAVY CONTRACT NO. NOW 63-0118-ci**



**BELL AEROSYSTEMS COMPANY**  
DIVISION OF BELL AEROSPACE CORPORATION-A **Textron** COMPANY

23636

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Buffalo, N. Y.

6 X-22A TRI-SERVICE V/STOL AIRCRAFT .

9 MONTHLY PROGRESS REPORT, no. 28, 1-31 Mar 65.

14 Report No. 2127-933028

~~March 1965~~

11 15 Apr 65,

12 20p.

This is the twenty-eight Monthly Progress Report as required in Section F(5) of the contract, and outlines progress for the period 1 March 1965 through 31 March 1965. For an illustration and a brief introduction of the X-22A program refer to reports prior to May 1964.

*A. J. Marchese*  
A. J. Marchese  
Project Director  
X-22A PROGRAM

*ad*



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## I. SUMMARY

Effort during the period was concentrated on the completion of aircraft No. 1 (Bu No. 1520) and on efforts required to continue the transmission system formal qualification on the test stand. Engineering liaison continued with shop and laboratory efforts. Flight test instrumentation progressed and test procedures were reviewed for coordinated efforts.

During March, the empty weight calculation for the aircraft increased 13.7 pounds to a total of 549.8 pounds over target. The increases were in access door additions, general interference and installation changes, landing gear and electrical installation.

The Spin model test report was submitted to BuWeps. Analyses and test report preparation continued on the 1/3 and the Full Scale powered duct models. Activity on the powered Free Flight model is expected to resume in April. Data from the 4/7 Scale powered NASA-Ames model tests will be sent to Bell early in April.

The Propulsion System test stand operated 12.0 hours during March, in which 11.0 hours of transmission qualification time was accumulated. However, on 6 March, tests were stopped as wear in the gearboxes was detected. This was in part caused by bearings turning in their bore mountings. The full set of boxes were returned to SPECO for rework and repair which included tightening of the bearing interference fit, plating to inhibit fretting, increasing the torque of bearing retaining nuts, and to replace some installations of titanium with steel. The repairs were completed and the reinstallation was in process at the close of the period. Stand resumption is scheduled for 5 April.

Phase I hydraulic system tests were satisfactorily completed and Phase II tests while progressing normally, were interrupted 15 March on the Flight Control - Hydraulic Test Stand. This was done to install the duct rotation system, incorporate required changes in the mixing box and rework swivel fittings at the elevon. This work is scheduled for completion in mid-April, for resumption of elevon instability tests and the last phase of hydraulic system testing.

The second aircraft set of components have progressed, paced by the vendors completion of the duct support tubes, their spinning and mating with the harmonic drive units. The wing, fin and other components are completed for final assembly installation.

The static test article and components are moving well into completion. Fixtures for static testing, and the instrumentation required have progressed for the start of tests scheduled in May.



2 pages  
A full project coordinated effort in the shop has continued through the period to complete the manufacturing phase of aircraft No. 1, Bu No. 1520, in mid-April. It is then scheduled to the flight test department for completion of systems functional checks prior to rollout. The program planning as of the end of March is shown on the program schedule (see Figure 1).

Planning for the formal rollout ceremony of aircraft No. 1 on 25 May 1965 is continuing between Bell and BuWeps. Invitations will be extended to representatives of all services and the aircraft industry to attend.



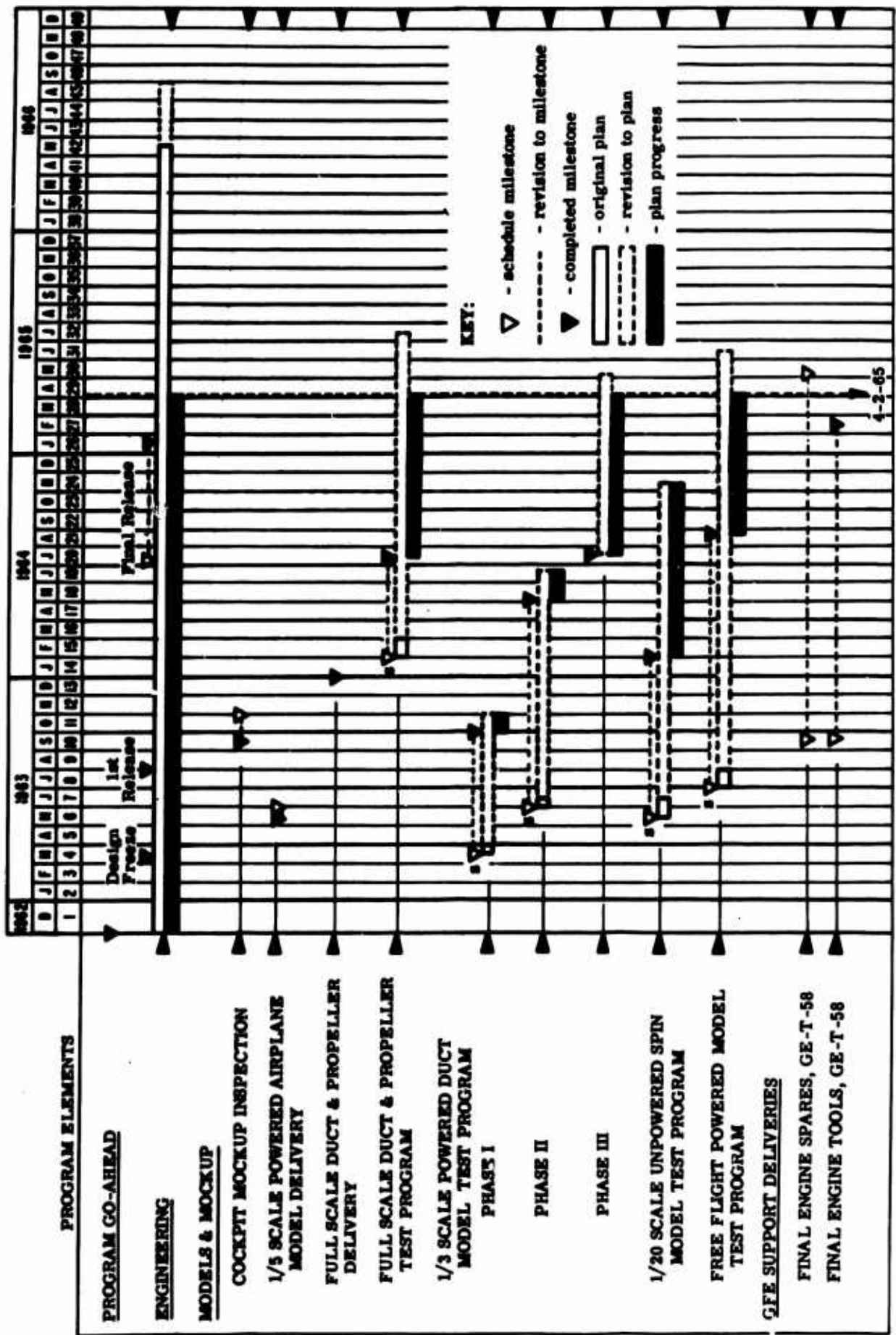


Figure 1. X-22A Program Schedule (Sheet 1 of 4)

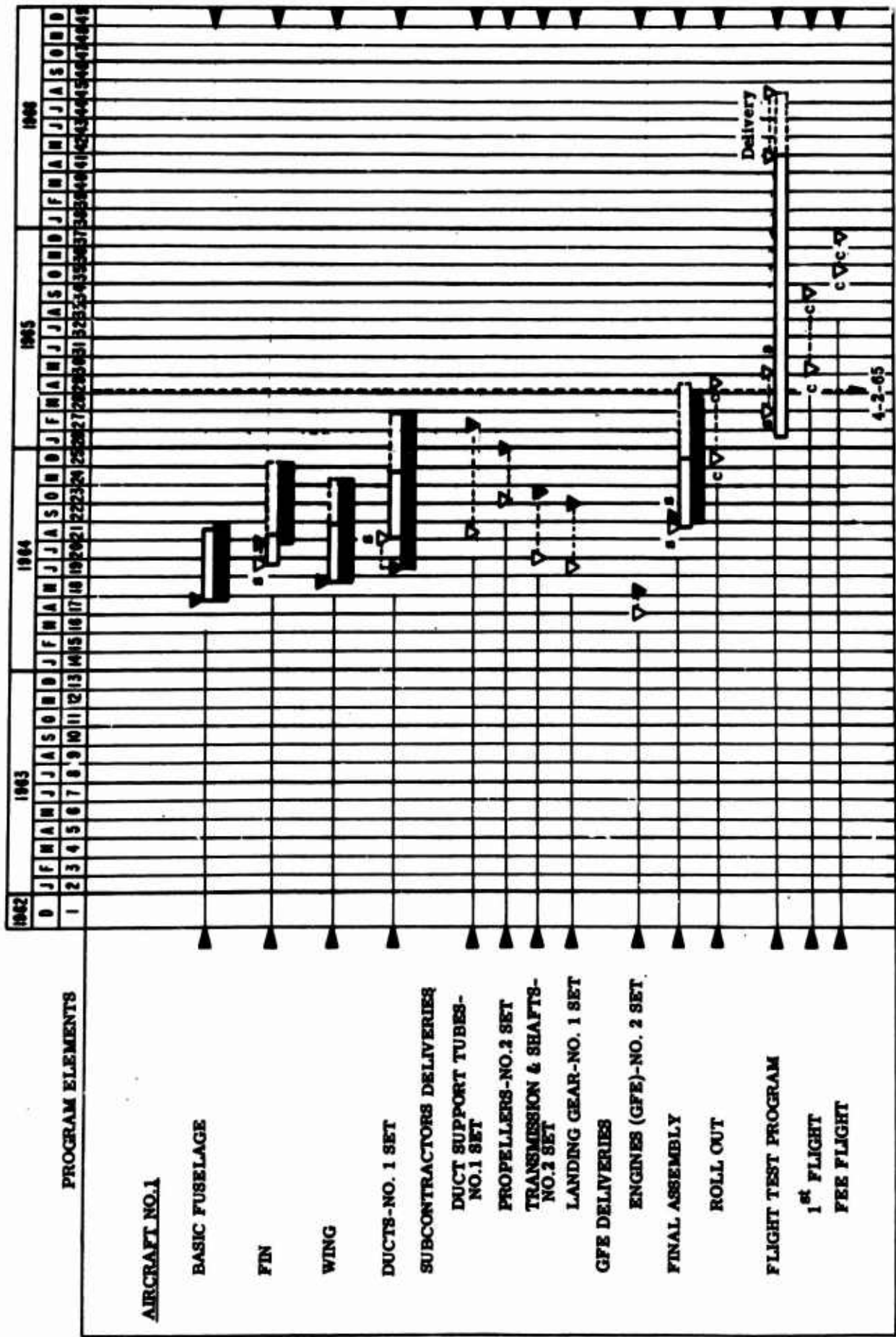


Figure 1. X-22A Program Schedule (Sheet 2 of 4)

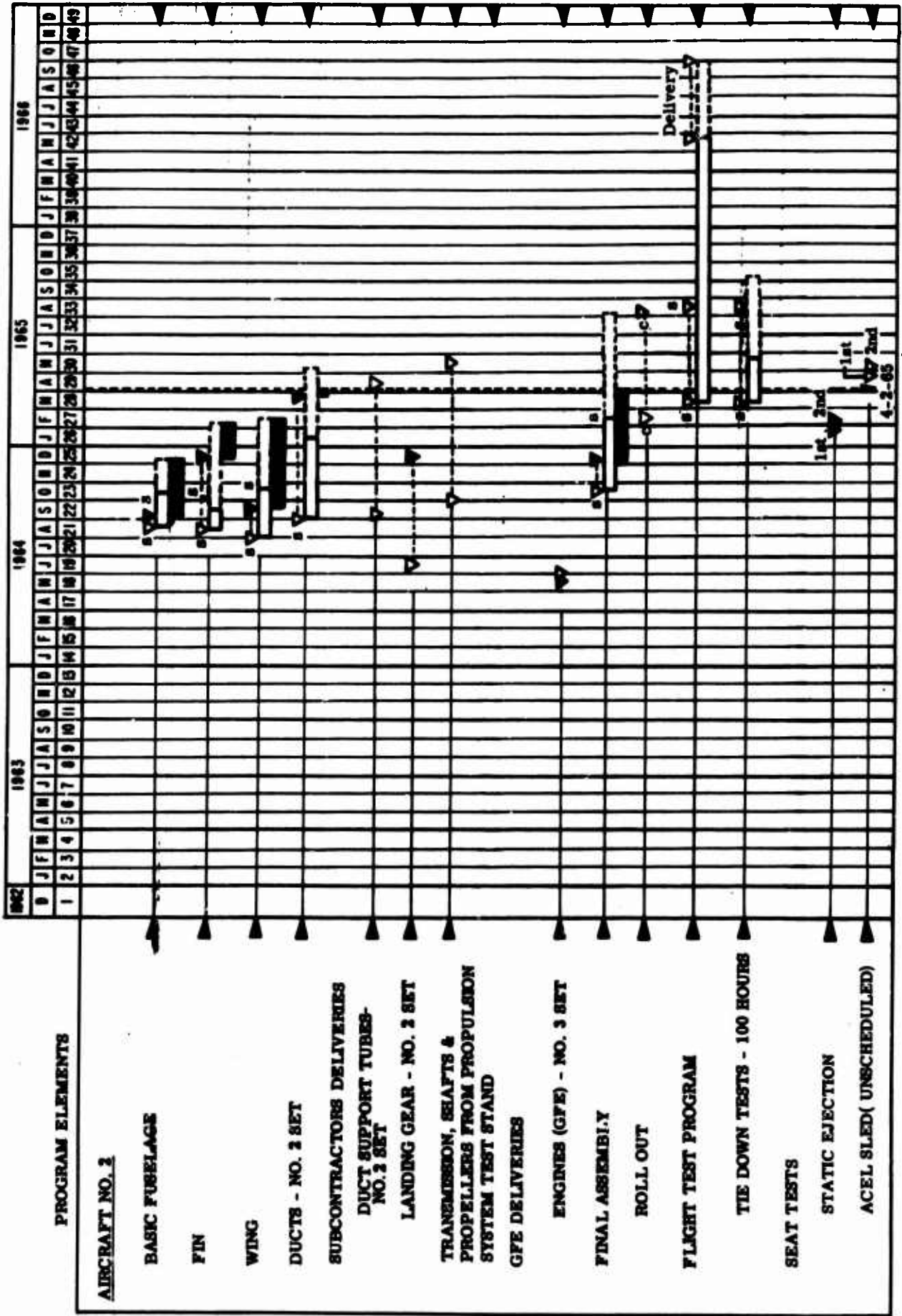


Figure 1. X-22A Program Schedule (Sheet 3 of 4)

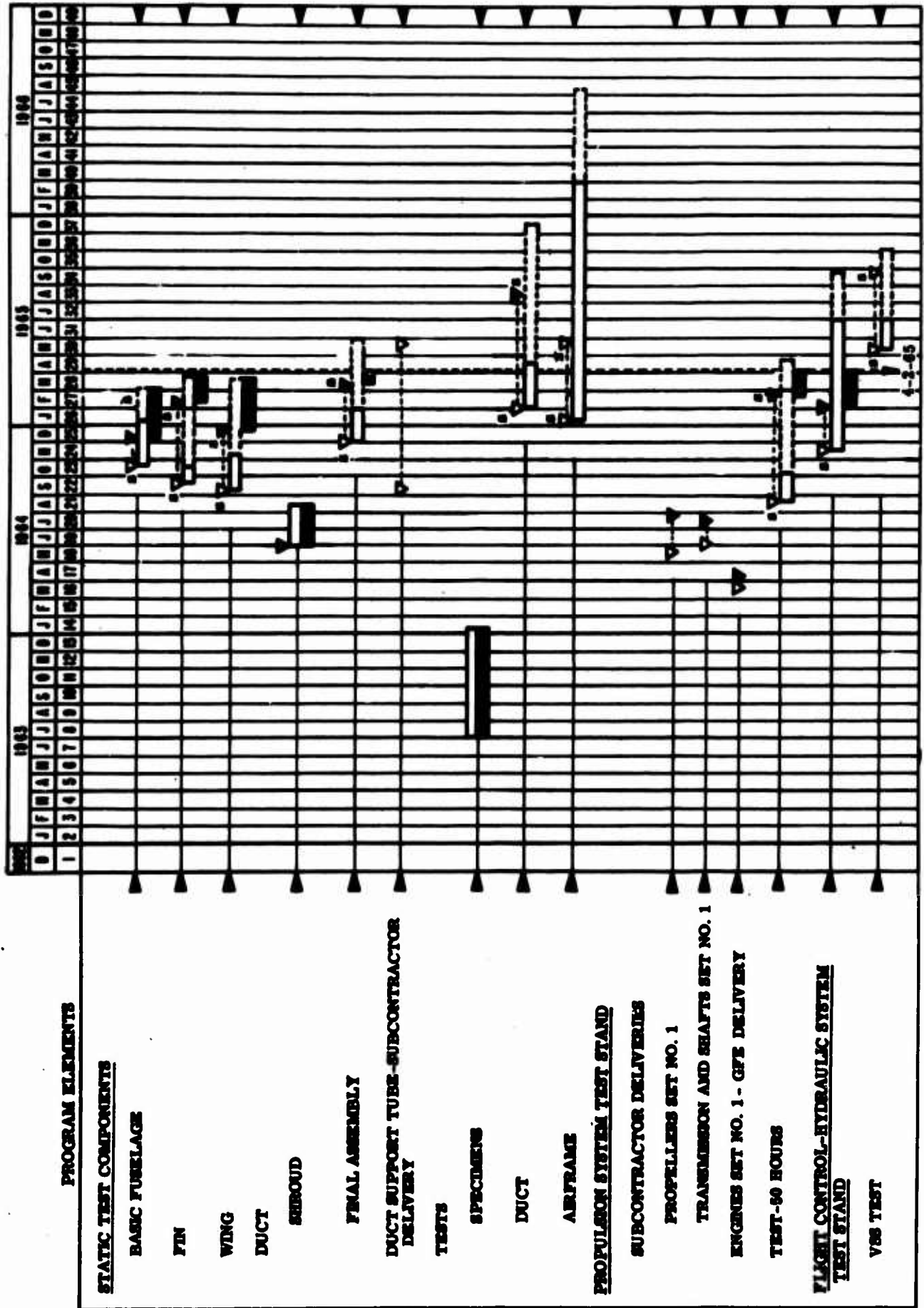


Figure 1. X-22A Program Schedule (Sheet 4 of 4)

## II. DESIGN

### A. FLIGHT TECHNOLOGY

#### 1. Performance

The drag and propulsion data for the second issue of the standard aircraft characteristics charts was discussed in a meeting at BuWeps. Verbal agreement was reached on drag values. BuWeps will discuss propulsion data with NASA-Ames.

#### 2. Stability and Control

Work was begun on the seventh revision to the stability and control report which is scheduled for submittal in April. The revision will incorporate the hinge moment data, duct stall boundary effects and propulsion data which were obtained from the results of the Phase II, full scale ducted propeller model tests.

#### 3. Propulsion Analysis

Using the latest engine specifications, the installed engine performance has been calculated for use in performance calculations. Final data have been received from Ames for the full scale ducted propeller model tests. These data will be used in final propulsion efficiency predictions.

### B. VEHICLE STRUCTURES

#### 1. Criteria and Loads

Elevon buffet loads measured during Phase II testing at NASA-Ames have been investigated from a fatigue point of view. Due to structural differences between the test elevon and the flight hardware, the elevon actuators on the left side of No. 1 airplane have been strain gaged and calibrated for load measurement. This will provide more accurate data for analysis.

Analytical work has been concentrated on the determination of magnitudes and distributions for the aerodynamic loads report.



## 2. Structural Tests

Work was continued on evaluation of the drop test program for preparation of the drop test plan report. An investigation of the availability of the special equipment required in the drop test program was initiated.

The revision of the Report 2127-929001, "Status of Structural Test" has been drafted and is being reviewed. Methods for monitoring strain and deflection data while conducting the static tests was investigated. Fabrication of the basic structure for supporting the static test airframe, the special tension pads for the vertical fin loading, and the basic support structure for the aft duct assembly have all been completed. Work is continuing on the design and fabrication of whiffle trees and loading arrangements for the aft duct assembly tests.

The detail planning of loading jack assignments for the engine mount, fin, fuselage, wing and landing gear tests was completed.

## 3. Aeroelasticity

To establish system natural frequencies, a forced vibration survey of engines and propulsion system shafting and gearboxes on aircraft No. 1 is scheduled prior to rollout. Engine crotches, fuselage shaft bearing hangers and representative gearboxes will be monitored during initial runup.

Detailed planning for the ground forced vibration test is in progress. The nose boom containing pressure pickups and pitch and yaw vanes has been checked for natural frequency and found to have the fundamental at 8.0 cps. This meets minimum frequency requirements for compatibility with the variable stability system.

## 4. Weights

Weight empty increases totaling 13.7 pounds have been incorporated this month. The current overweight is now 549.8 pounds. Weight changes are for:

- (1) +1.8 pounds for additional access doors.
- (2) +3.1 pounds to eliminate interferences.
- (3) +2.9 pounds to facilitate installation
- (4) +3.0 pounds additional electrical requirements.
- (5) +2.6 pounds to provide thermal relief protection in the landing gear.
- (6) +0.3 pound for miscellaneous.

Weight and balance status report No. 13 was submitted to BuWeps during this period.





## C. DESIGN

### 1. General

Manufacturing liaison and test stand coordination are the major items of work in the design area. During this report period, elimination of interferences and the addition of access openings were accomplished.

### 2. Airframe

The major efforts in airframe design are drawing changes and liaison with manufacturing. Engine cowls and landing gear doors required minor rework action to provide good match up of mating surfaces. Access panels to facilitate installation and servicing of components and airframe rework to eliminate interferences have been incorporated as necessary.

#### a. Flight Controls

Revisions and additions to the flight control rigging procedure were completed and distributed to the operating departments.

Rework on the United Shoe Machinery wave generators for the harmonic drives is being investigated by the vendor and Bell. Tests required to prove the drive design were defined.

The elevon stability problem found on the flight control hydraulic system test stand was corrected on the aircraft by adding a spring preload in much the same manner as on the test stand. Completion of the Procedure II hydraulic subsystems tests is awaiting the final installations of components on the test stand. The duct rotation harmonic drives and simulated ducts are being installed on the test stand. Changes to trim and feel system specifications were accomplished.

Design of covers and guards for the mechanisms in the mixing box was completed. Design of the elevon load relievers for the rear elevon actuators was initiated, and attitude stick changes to accommodate variable stability system requirements were completed.

Normal engineering liaison with manufacturing during fabrication and installation of control system components into the flight aircraft is in progress.

#### b. Equipment and Ground Equipment

Design of the installation of duct rotation switches on the pilot collective pitch sticks was released to manufacturing.



### 3. Propulsion Design

#### a. Propulsion Design (Aircraft)

There has been no effort on new hardware for the aircraft during this period. Special tools have all been made for the airplane transmission installation. several drawings are being completed for special tools that were fabricated during assembly installation.

#### b. Propulsion System

Propulsion liaison with manufacturing systems installations continued through March and updating of the propulsion schematics progressed. The checkout procedures for the X-22A Propulsion System on the airplane were completed.

On occasions, since the Propulsion System Test Stand was initiated, the engines have evidenced an area of intolerable vibration. Checks have isolated the Transmission System from the basic engine to pin-point the sources.

Each time an engine change was made, for FOD, seizure, etc., a vibration problem arose. The four original engines were of the more current split bearing power turbine configuration, while the available replacement engines included an earlier 1 piece bearing power turbine. In each occasion, the vibration was eliminated by our removal of the Power Turbine, from the replacement engine and reinstalling the Power Turbine from the original engine.

With the recent engine seizure the engine was shipped to overhaul on priority DIR. The results have not localized the vibration source. However, as the more current split bearing power turbine installations have been satisfactory to date, Bell has recommended that an equal exchange be arranged to supply all of the latter configuration engines to free the program from further delay and increased cost from this problem. This is being currently discussed with BuWeps.

### 4. Hydraulic and Landing Gear

Major engineering effort has continued in the preparation of checkout procedures

#### a. Landing Gear

Both the landing gear and brake system check out procedures have been completed.



The gear manufacturer is replacing all retraction actuator bodies with steel parts as a result of damage which occurred when the main gear was allowed to free-fall.

The brake assemblies were reworked by Goodyear for attaching a disc guide to prevent excessive axial movement of the brake disc.

**b. Hydraulic System**

The Flush, Fill, and Check-out Procedure for the aircraft has been completed.

The rework on the first forward roll-yaw boost actuator was completed and the actuator has been satisfactorily installed in aircraft No. 1.

The addition of pressure-operated by-pass valves in the duct rotation system is under investigation. This would eliminate a possible hydraulic lock condition in the event that one hydraulic system fails.

The vendor design approval test report on the pitch boost actuator was reviewed and approved. Based on the test results pins on this actuator, and similar pins on the two roll-yaw boost actuators, will be replaced with pins of different material and hardness prior to first flight.

**5. Electrical and Electronics**

Liaison with manufacturing was the major activity during the month. A checkout procedure of the electrical system for the aircraft was completed. Drawings were issued on the installation of the automatic direction finding receiver.

**D. SYSTEMS SUPPORT**

Recent revision to the propeller system is being studied for inputs to the inspection requirements handbook. The maintenance handbook continued in preparation and changes to Aerospace Ground Equipment were coordinated.

**E. SYSTEMS ANALYSIS AND SIMULATION**

Effort progressed in the areas of:

- (1) The acceptance and handling of flight test calibration data;
- (2) Reduction and summarization of propeller actuator response and thrust response to throttle steps;

- (3) Troubleshooting test procedures for elevon and pitch boost stability;
- (4) Liaison support during fabrication and testing of stability augmentation, feel and trim, and the variable stability systems.

### III. MODELS

#### A. WIND TUNNEL TEST PROGRAM

##### 1. 1/3-Scale Powered Duct Model

The final data report for this model is approximately 40% complete. It is being prepared without inclusion of the static test of the model which has been delayed at David Taylor Model Basin.

##### 2. Full-Scale Powered Duct Model

Final data for this model have been received from NASA-Ames and are being analyzed.

##### 3. 1/20-Scale Spin Model

The data report for this model was submitted to BuWeps on 23 March 1965.

##### 4. Powered Free-Flight Model (0.18 Scale)

There has been no activity on this model due to higher priority projects at NASA-Langley. Testing is expected to resume in April.

##### 5. 4/7-Scale Powered Airplane (NASA-Ames) Model

A second series of tests was conducted on this model in the NASA-Ames 40 by 80 foot wind tunnel. The tests included ground effects in hover, transition, and level flight configurations. The data will be supplied to Bell early in April.

#### IV. TEST STANDS

##### A. PROPULSION SYSTEM TEST STAND

The test stand was operated for 12.0 hours during the month. As of 31 March 1965, the test stand was operated for a total of 65.0 hours and 11.0 hours of qualification time was accumulated.

Repair of the propeller transfer bearing that was damaged last period was completed 1 March and test stand operation resumed on 2 March. On 3 March, a fuel control malfunction occurred on engine No. 4 which produced an overspeed and overtorqued condition. The gas generator and fuel control portion of the engine were replaced and testing resumed again on 5 March. During operation on 5 March, there was positive indication of metallic (magnetic) particles in forward fuselage (No. 10) gearbox. This occurred again on 6 March for No. 10 and also aft fuselage (No. 9) gearbox. Testing was terminated on 6 March when oil temperature for No. 10 gearbox increased suddenly from 85 to 108°C.

A detailed examination showed that wear caused by some of the bearings turning on their bore mountings was taking place in the forward and aft fuselage gearboxes and in the four engine gearboxes. The full set of transmissions was returned to Steel Products where the necessary repairs were made. This included tightening up of the interference fit on the bore of the affected bearings, silver plating the shafts to assist in inhibiting fretting, and increasing the pinch on the bearings by torquing the retaining nuts to a much higher value and replacing an inner race and titanium spacer on the fuselage gearboxes with a specially designed roller bearing inner race. In addition, some of the liners were changed from titanium to steel.

These repairs were completed and the last gearbox was shipped back to Bell on 31 March 1965. The 50 hour qualification test is expected to resume 5 April.

It should also be noted that other than the wear condition noted above, the transmissions were in excellent condition. Gear tooth faces showed no discernable wear, bearings showed no wear on their contacting surfaces and no cracks or other structural failures were found in any of the transmission hardware.

##### B. FLIGHT CONTROL - HYDRAULIC SYSTEM TEST STAND

Formal hydraulic system testing was satisfactorily continued to 15 March 1965 using a simple spring preload to compensate for the elevon instability condition. At this time, testing was stopped to permit installation of the duct rotation system, incorporate the latest changes in the mixing box assembly and rework the elevon actuator swivel fittings. This work is expected to be completed 19 April 1965 and elevon instability testing and the last phase of hydraulic system testing will resume at this time.



## V. MANUFACTURING

The shop effort continued in the last phases of component assembly and systems installations. Both aircraft final assembly operations progressed and the static test article and static components approached their completion points.

**Duct Assemblies** - The first ship set of ducts were completed and mated with duct support tubes and harmonic drives. A fifth duct has been completed and has been mated with the duct tube, which tube is now at United Shoe Machinery Co. being matched with a harmonic drive assembly. Three additional duct assemblies have been completed and are held waiting for the duct tubes from the vendor. A ninth duct shroud is nearing completion in the fixture and will be completed with the incorporation of the duct support tube when available.

**Strut Assemblies** - One duct assembly is having the strut and centerbody assemblies mated. A second complete set of struts and centerbody is ready for assembly with the duct upon the availability of propeller and gearbox. Two additional centerbodies are currently in work. All horizontal and auxiliary struts for the second aircraft have been completed, with the vertical struts nearing completion.

**Elevons** - The four elevons for aircraft No. 1 have been processed through rework. Two of the second set have also been completed, a third in final riveting and the fourth due to be started in the fixture early in April. The tri-plane elevon details are in work and the initial assembly fixtures have been completed.

**Stabilizers** - Number 1 set of stabilizers (rear wing tips) have been completed, painted and installed. The second set have been completed and are ready for painting.

**Cowls, Landing Gear Doors and Inlets** - Both the number one set of nacelle cowls and main landing gear doors have been completed, fit to ship and in painting. The second set are in subassembly and in fixtures. The second aircraft air inlet assemblies are in subassembly work.

**Fin and Wing** - The second fin assembly was completed in the shop and checked in the Engineering Laboratory. The third fin was started in the fixture 1 March. The instrumentation has been completed and the skinning closeup is in progress for completion early in April. The third wing was completed 25 March and is available for static test installation.



Final Assembly - Bu No. 1520 (aircraft No. 1) has moved along with top priority. All four ducts with propellers have been installed and harmonic drives connected. The electric cabling and hookups have continued. Tubing is being mocked up and installed as system installations progress. The cleaning and painting of the aircraft has been completed as far as possible and cockpit furnishings placed and completion in process. The landing gear and doors, and elevon controls have been installed. Flushing and rigging procedures are being prepared.

Bu No. 1521 (aircraft No. 2) is following in final assembly. The wing has been installed and the fin available for fit. System installations are underway. The cabin, cockpit and tank areas have been completed. The nose gear is on hand for fit. One right propeller is available and in work for installation. The other right and two left propellers as well as transmission gearboxes and shafts will be available later from the propulsion system test stand. This availability controls the completion of aircraft No. 2.

The third fuselage, the static test article, was removed from the fixture and located on the final assembly area 2 March. Cleanup work and change incorporations has continued. The instrumentation wiring has been accomplished. Installation is progressing with the wing and the engine mount. The nose gear has been received from the vendor for installation.

Shop continued the support of both test stands on a priority basis, coordinated with engineering and vendors efforts. Various items of ground handling equipment also continued in work.

## VI. SUBCONTRACTORS

### 1. Propellers - Hamilton Standard Division United Aircraft Corp.

A Hamilton Standard representative was at Bell during the initial qualification running of the propulsion system test stand early in the month.

The Numbers 9, 10 and 11 propellers were received by Bell during the month of March. The pump problem on the master control was resolved, and the Number 2 unit was delivered to Bell. The third unit will be shipped in April.

The two T-58 engines from the test stand are being removed and after inspection will be returned to Bell for aircraft installation.

### 2. Variable Stability System - Cornell Aeronautical Laboratory

The detailed design, fabrication and analyzing of the 10 variable stability system cockpit panels has been completed. Electrical fabrication of the last 12 of the 30 drawers of variable stability system equipment was completed and electrical check-out of drawers has been completed.

Fabrication of the 2nd low range airspeed system rotating head assembly continued.

Plans were prepared for the variable stability system artificial feel system tests on the Bell flight control hydraulic system test stand. A location was selected for the artificial feel system strain gages which required rework for clearances.

### 3. Transmission System - Steel Products Engineering Company

SPECO engineering representatives were at Bell to investigate oil leakage and to witness disassembly and assist in the overall gearbox problems.

During the month, all gearboxes from the propulsion system test stand were shipped to SPECO for inspection and rework. The rework was completed and all gearboxes were returned to Bell by the end of March. SPECO is proceeding with design work for a backup configuration of the 1130-1 and 1158-1 pinion and gear.

### 4. Landing Gears - Loud Company

Due to a structural failure, the actuators for the side brace on the main landing gear are being replaced with an actuator body made of steel. An engineer from Loud Company investigated this failure at Bell.



The Number 2 and the static test nose landing gears were received at Bell. The static test main gear was scheduled for shipment on 1 April. Loud was instructed to hold the Number 2 set of main gears for the replacement of the actuator expected approximately 1 May.

5. -136 Duct Support Tubes - 20th Century Machine Company

Invincible Gear Company, the splining subcontractor for 20th Century, experienced delays in modifying equipment to make it suitable for grinding the 360 tooth spine. This was overcome during March and the Number 5 duct support tube was completed and shipped to the platers, prior to shipment to Bell.

The Numbers 6 and 8 duct support tubes are currently having the splines ground. Due to the nature of the specialized splining, there has been a continual slipping of projected schedules from this vendor for the duct support tubes. All efforts to hold production schedules are being maintained by Bell.

6. Harmonic Drive System - United Shoe Machinery Corporation

Dimensional corrections were made to the existing wave generators by chrome plating. The second plated unit was utilized in the drive assembly mated with the Number 3 -014 duct support tube. This unit passed all required tests, and has been received at Bell.

Bell added a life test and pinion load test to be performed on the Number 10 unit, with a wave generator that had been chrome plated.

On 31 March United Shoe reported that a flaking condition occurred during grinding of the third wave generator. An investigation of the process is now underway.

The Number 5 -136 duct support tube was shipped from Bell and was received at United Shoe on 31 March for mating with harmonic drive.

7. Viscous Dampers - Sikorsky Aircraft Division, United Aircraft Corp.

The first two viscous dampers, delayed through February, were received 5 March. The balance of four units were received in the last week of March ahead of the scheduled promise date, closing out the requirement.

8. Gear Sectors - Morand Corporation

Bell experienced problems in heat treating the gear sectors to submit them in satisfactory condition for machining by the Morand Corporation. They were shipped to Morand on 31 March.



VII. GENERAL

A. TRIPS AND VISITORS

1. Trips

<u>Date</u>	<u>To</u>	<u>Purpose</u>
3/16/65	BuWeps	Performance and Technical Discussions
3/29 - 30/65	NAEC-ACEL	Ejection Seat Sled Test Planning

2. Visitors

<u>Date</u>	<u>From</u>	<u>Purpose</u>
3/3-4/65	BuWeps	Monthly Program Status Review

B. OPEN ITEMS (Submitted at least 30 days prior to 31 March 1965 to BuWeps and BuWeps Representative)

<u>BAC Letter No.</u>	<u>Subject</u>	<u>Date Submitted</u>	<u>Required Approval Date</u>
468	General Arrangement Drawing	12/2/63	*
512	Preliminary Environmental Vibration Report (932002)	1/31/64	*
636	Inertia Loads Report	5/13/64	*
669	Substantiating Loads Data Report (941009)	6/10/64	*
691	Return of Executed Document C/N5771-64	7/22/64	*
714	Flight Loads Criteria Report	8/17/64	*
725	Vibration Program Report Revision	9/4/64	*
772	VSS Specification - Part II, BAC Report 947024	11/5/64	*
773 (CP-55)	Two Miscellaneous Specification Revisions	1/9/65	*

<u>BAC Letter No.</u>	<u>Subject</u>	<u>Date Submitted</u>	<u>Required Approval Date</u>
809	Demonstration Instrumentation Report 936001	1/14/65	*
816	Hydraulic and Pneumatic System, Use of Non- Standard Fittings	1/26/65	*
835	Test Procedures for 50-Hour Propulsion System Bench Test Qualifications	2/25/65	*

\* BAC has scheduled a 30 day interval for approval by BuWeps of each of these submittals after BuWeps Representative's endorsement.

**BELL AEROSYSTEMS COMPANY**

**BUFFALO 5, N. Y.**

**835:5:0422-2:AJM/ALS  
22 April 1965  
Letter No. 866**

**To:** Chief, Bureau of Naval Weapons  
Department of the Navy  
Main Navy Building  
Washington 25, D. C.

**Attention:** RA-443

**Subject:** Contract NOW 63-0118-c1  
X-22A Research Aircraft  
Monthly Progress Report No. 28 (March 1965)

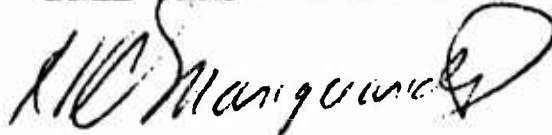
**Reference:** (a) Navy Contract NOW 63-0118-c1, Section (F)-5

**Enclosure:** (A) Five (5) copies of Monthly Progress Report  
No. 28 - March 1965 - BAC No. 2127-933028

**Via:** BWR (Bethpage Technical Representative)  
Bell Aerosystems Company  
Post Office Box 1  
Buffalo 5, New York

1. Enclosure (A), the 28th X-22A Monthly Progress Report, is submitted in accordance with the requirements of Reference (a) and covers progress through March 31, 1965.

**BELL AEROSYSTEMS COMPANY**



7m

**A. J. Marchese  
Project Director**

**AJM/ALS:mb  
Enclosure**

**cc: See Attached Sheet**

BELL AEROSYSTEMS COMPANY

835:5:0422-2:AJM/ALS  
22 April 1965  
Letter No. 866

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